

6179
Antique Wireless Association Monograph

(New Series) No. 3

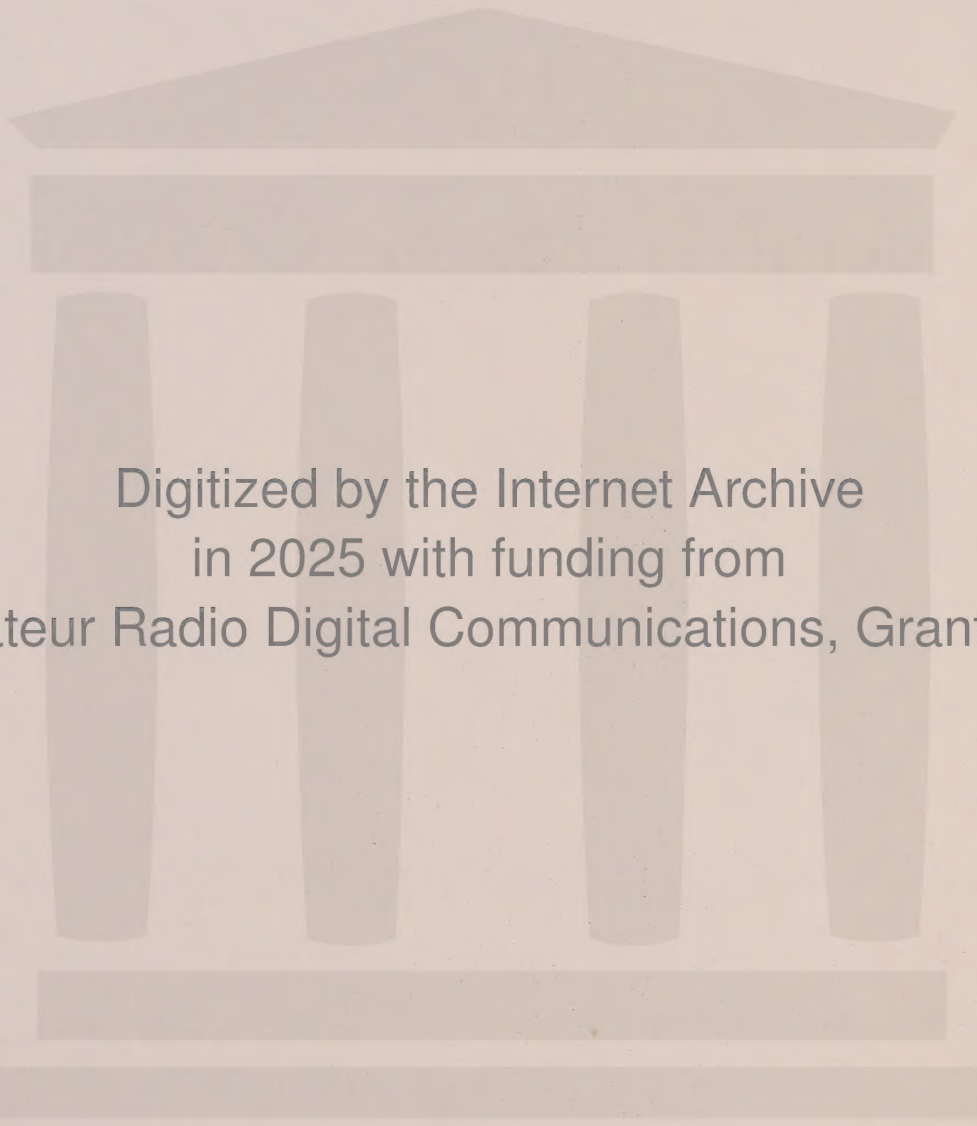
The
Federal Telegraph Company

1909 - 1920

by

Thorn L. Mayes, W6AX

*General Electric Co., retired; Technical Director,
Society of Wireless Pioneers*



Digitized by the Internet Archive
in 2025 with funding from
Amateur Radio Digital Communications, Grant 151

<https://archive.org/details/chrs-lib-28>

The Federal Telegraph Company

1909 - 1920

by

Thorn L. Mayes, W6AX

General Electric Co., retired; Technical Director,

Society of Wireless Pioneers

This paper covers the accomplishments from 1909 to 1920 of a small group of courageous, far sighted, engineers and financiers who in 1909 formed a company for the purpose of setting up and operating a wireless telegraph system along the west coast of United States.

They introduced in the United States the first commercially successful system of continuous wave wireless telegraphy, a major improvement over the spark system currently in use, introduced by Marconi.

Their engineers took the small inefficient arc transmitters built by their inventor Valdemar Poulsen of Denmark and developed the high power, high efficiency sets so badly needed by our Navy. Because of the superior performance of their transmitters and their ability to design progressively larger units, Federal built a major part of the long distance wireless sets used by our Navy just prior to and during WW-I, ending with the 1000 KW transmitter installed by the Navy in France at the end of WW-I.

By the end of the War, Federal's heavy manufacturing period was over since the Navy's requirement for large transmitters had been met. When commercial radio stations were returned to their owners, RCA had been formed and had taken over the Marconi Wireless Telegraph Company of Amer-

Thorn L. Mayes, old-time GE executive, is - besides other things - Vice-President and Consulting Engineer for the Perham Foundation, which established the Foothill Electronics Museum at Foothill College Space Science Center, Saratoga, California. Thorn is a historian of early wireless companies of this country and has published much material including articles on Alexanderson, American Marconi Company. He is also known for his unique tape collection which reproduces the many sounds of spark. He received the 1971 AWA Houck Award for his outstanding historical documentations.

ica. Because of the excellent performance of the continuous wave 200 KW Alexanderson alternator transmitter installed in the New Brunswick, New Jersey station during the War, RCA decided to use these transmitters for their worldwide operation, not the arcs. So Federal continued as a profitable communications company on the west coast of the United States, fully developing the arc transmitter for the purpose.

I am indebted to Dr. L. F. Fuller for much of the material in this paper, from a talk he gave at Foothill Electronics Museum in April, 1974¹ and from many conferences with him since then.² His help and guidance made the paper possible. Other former Federal employees and commercial operators who furnished details are Eb Cady, Bob Seal, Cliff Cannon, Fred Hoehn, Bill Breniman, Earl Wohler and Jack

Slater. Gerald Tyne furnished information on Lee de Forest during the period he was with Federal, and details of operation of the company to 1914 from June 1, 1914³ Secretary's report by H. P. Veeder.

Federal engineers did not invent the continuous wave system. Professor R. A. Fessenden in 1903, using a 1 KW 10 KHz alternator, demonstrated the use of undamped waves in wireless telegraphy. In December 1906 he was the first to transmit voice over a long distance.⁴ Using a 1 KW 50 KHz alternator to generate the carrier, his program, sent out Christmas Eve, 1906 from his station in Brant Rock, Massachusetts, was heard as far South as West Virginia. But his use of continuous waves was for experimental purposes only.

Development of the direct current arc as a generator of radio frequency power is described by Professor G. W. Pierce in his text, "Principles of Wireless Telegraphy," published in 1910 as follows-⁵

"Elihu Thomson while experimenting with early arc lights found that if a direct current source of 500 volts, producing an arc across a spark gap in a strong magnetic field, was shunted by a circuit containing inductance and capacitance, then electrical oscillations were generated in that circuit.

"Duddell in 1900 using the Thomson circuit, but substituting carbon electrodes for metal in the spark gap, found that by proper adjustment of values of inductance and capacitance in the shunt circuit, the arc would generate an audible note but at very low power levels. This was known as the singing arc.

"Valdemar Poulsen while experimenting with Duddell's generator, found by accident that the vapor from a small alcohol lamp, when introduced into the arc, appreciably increased the amount of radio frequency current generated."

This was announced by Poulsen in 1903 who continued his experiments and by 1909 had used the radio frequency energy generated by the arc to power a wireless transmitter used to transmit both telegraphic signals and voice. He also substituted a water cooled electrode for one of the carbons

which aided in dissipating the heat generated by the arc.

C. F. Elwell a graduate of Stanford University, completed a consulting job early in 1909 involving wireless telephone transmission using damped waves generated by a spark coil as the carrier. This system was a failure, but he had read of Poulsen's work and felt the arc approach was promising.

In May 1909 with the financial help of several Stanford professors, Elwell went to Denmark to see first hand what Poulsen had accomplished. He witnessed telephone communication over a distance of 10 miles, telegraphy 180 miles.⁶

U. S. patent rights for use of the Poulsen system were offered for \$450,000 but Elwell was given an option on them for \$1000 if he also purchased a 5 KW and a 12 KW arc transmitter for \$6,000.⁷ Elwell returned to the U. S. but in spite of his enthusiasm for the arc system, found little support from the Wall Street financiers in investing in another wireless company after the stock-selling sprees of the Gehring and de Forest wireless companies. He returned to Denmark and was able to negotiate a contract with much lower initial cash payment but including stock in the company to be formed in the U. S.

Elwell brought a small 100 watt arc back from Denmark and with it set up in Palo Alto a demonstration of wireless telephony. Several Stanford pro-

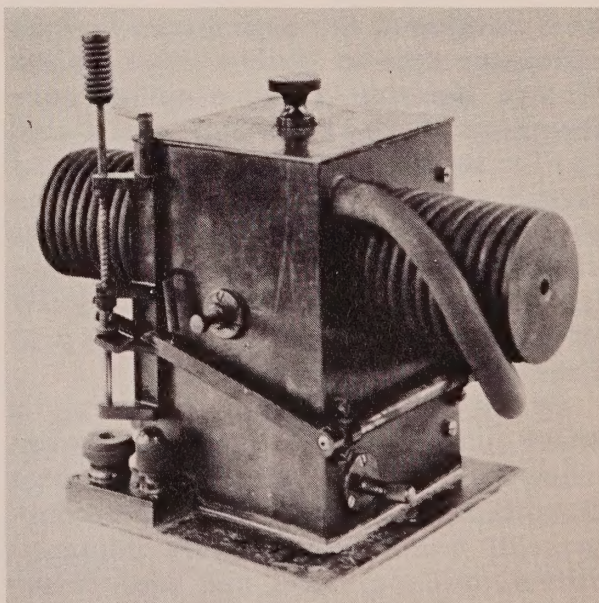


Figure 1 - 100 Watt Arc Converter of 1909 from Denmark.

fessors and Palo Alto business men witnessed the demonstration which took place in mid 1909.⁸ This small converter is now on display in the Foothill College Electronics Museum.

As a result of the demonstration, enough money was raised to finance the formation of the Poulsen Wireless Telephone and Telegraph company in October 1909 under the laws of the State of California. Elwell was a Director and chief engineer.

Following the stock-selling procedures used by earlier wireless companies, two stations were built fifty miles apart to demonstrate the capabilities of the equipment. Sites were leased in Sacramento and Stockton,⁹ California and the transmitters purchased from Poulsen were used in the two stations. Elwell had also contracted to have three Danish engineers come to the U. S. to install the sets. One of them, Peter Jensen, soon left Federal with a Federal engineer, E. S. Pridham, to form the Magnavox company to design and manufacture loud speakers.

The two stations were officially open-

ed February 1910 and an article describing the successful communication between them was reported in the Sacramento Sunday News of February 20.

This demonstration resulted in added stock sales but not as much as hoped for; so it was decided to build a third station to show that two or more arc transmitters could be operated simultaneously and not interfere with each other, due to the sharpness of the emitted waves.

Land was purchased on Ocean Beach, San Francisco, two 300 foot masts were erected and the 12 KW Danish arc was installed. This station was put into operation July 1910 and Figure 2 shows its interior.¹⁰

Beach Thompson a San Francisco financier, attended the station opening. He was favorably impressed with operation of the three sets and upon learning that the company was low on funds, proposed a reorganization with the formation of a new company to provide the money needed for expansion.

In February 1911 the Poulsen Wire-



Figure 2 - San Francisco Beach Station 12 K.W. 1910.

less Corporation was formed which absorbed the Poulsen Wireless Telephone and Telegraph Company. Beach Thompson was president with Elwell as chief engineer. Several San Franciscans invested in the stock and bonds of the new company so a new agreement was made with Poulsen who was paid \$500,000 plus bonds in the new company, for the exclusive rights to his patents for use in the United States and its possessions plus the Philippines, Puerto Rico and Cuba.

All patent rights and titles to the operating stations were transferred¹¹ to a newly formed Wireless Development Company which had a capitalization of only \$100,000. This move was made to reduce State taxes as many States taxed a corporation on the basis of its capitalization.

The name of the Wireless Development Company was changed to the Federal Telegraph Company in July of 1911.

The Danish transmitters were designed for intermittent operation, so overheated and had to be shut down periodically to cool off; also, their efficiency was low. Elwell felt the designs could be improved and if built locally the high import duty would be avoided, so a small shop was set up in Palo Alto for building the needed equipment.

Since little data was available on how continuous waves would carry over land, a duplicate of the San Francisco station was built in Los Angeles, a distance of 350 miles, which was opened in October 1910.

Communication between the four stations was so successful that an eastern chain of stations was considered. As a further test of overland transmission, a 12 KW station was built in El Paso, Texas in 1911; also a 5 KW station on top of the U. S. Grant hotel in San Diego, California. Other stations in the eastern chain were completed in 1911 at Kansas City, Fort Worth and early in 1912, at Chicago, with a relay station at Phoenix, Arizona.

West coast operations were extended north in 1911 with stations at Lents near Portland, and at Medford, Oregon. The Medford operation was not satisfactory so was replaced in 1912 by a

12 KW station at Central Point, a suburb of Medford.

After a year's successful experimental operation between the five California stations, they were opened for commercial business in June 1911.¹³ During the next nine months stations in the eastern and northwestern groups were also opened for commercial operations.

In competing with the land lines, Western Union and Postal Telegraph, Federal charged for a 15 word message the same as the telegraph companies charged for 10 words.

Table 1 shows the commercial wireless stations built by Federal. Period of operation is shown under years. Note that the eastern stations, with the exception of Phoenix, were closed by the end of 1913 and the remaining stations in 1917 when War was declared.

So far, the company had two objectives: to construct a west coast chain of stations plus one extending east as far as Chicago, to determine if the Poulsen system could successfully compete with the telegraph. And second, to development of an arc transmitter powerful enough for long distance competition with the transoceanic cables.

Soon after the 12 KW station was opened in San Francisco, an observer with receiving gear was sent to Hawaii.¹⁵ He heard the San Francisco station occasionally at night but reception was poor. Later in 1911 a 30 KW arc was imported from Denmark and installed in the Beach Station but this change made little difference in the Hawaii reception.

A new station was built in South San Francisco with two 440 foot masts and a duplicate constructed in Heeia, Hawaii. They were equipped with 30 KW sets designed and built in the Palo Alto shop.

These two stations communicated satisfactorily at night, so early in August, 1912, Federal began press service between San Francisco and Hawaii.¹⁶

The cable press rate was 16 cents per word but Federal started with 2 cents per word. Honolulu papers immediately went from 120 words per day of mainland news to 1500. Early Sep-

RADIO STATIONS OF FEDERAL TELEGRAPH CO.

Data from Veeder Report

Thru 1914

Station Location	KW	1909	1910	1911	1912	1913	1914	1915	1916	1917
Sacramento, Calif.	5									
Stockton, Calif.	5									
San Francisco, Calif.	12									
Los Angeles, Calif.	12									
El Paso, Texas	12									
San Diego, Calif.	5									
Kansas City, Mo.	12									
Ft. Worth, Texas	12									
Phoenix, Ariz.	12									
Portland (Lents), Ore.	12									
Medford, Ore.	12									
Medford (Central Pt.)	12									
Chicago, Ill.	12									
S. San Francisco, Calif.	30*									
Heeia, Hawaii	30*									
Los Angeles (Inglewood) Calif.	12									

*Changed in 1914 to 100 KW

TABLE 1

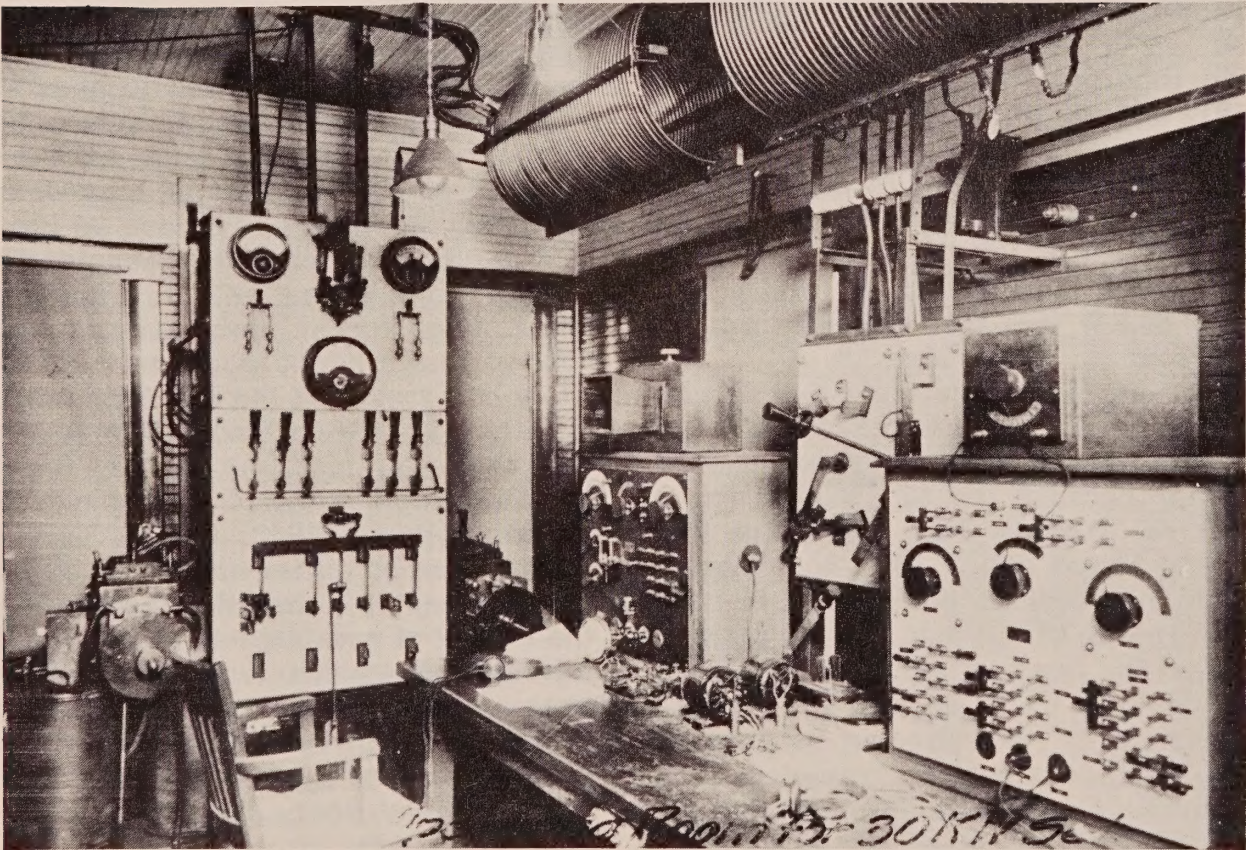


Figure 3 - South San Francisco Station 30 K.W. 1911.

tember 1912 the stations accepted night messages.

To insure daylight communication, a 608 foot mast was installed at each station and in January 1914 two 100 KW transmitters replaced the 30 KW sets. With these changes, day and night service was assured.¹⁷ The span from San Francisco to Hawaii of 2100 nautical miles or 2400 land miles was farther than across the Atlantic, a major accomplishment.

Summer static of 1912 proved that the 12 KW stations of the eastern chain to Chicago could not furnish dependable communication during the summer months, so work with them was terminated except for the Phoenix station which was kept open.

Elwell foresaw the need for larger transmitters and realized he badly needed a better understanding of the design and performance of arc transmitters.

Leonard Fuller graduated from Cornell University in 1912 and immediately went with National Electric Signalling Company where he worked on the design of small arc converters used to produce the beat frequency signal for Professor Fessenden's heterodyne receivers. Elwell met Fuller and offered him a job which Fuller accepted. He reported to Palo Alto September 1912 and was immediately assigned the problem of studying arc transmitter design for the purpose of improving performance and learning to build larger sizes. He was also given the immediate assignment of testing the new 60 KW unit that had been ratioed up from the 30 KW size.¹⁸

It was indeed fortunate that Elwell had recognized the weakness in his engineering know-how and had hired Fuller because the 60 KW unit was a failure. With an input over twice that of the 30 KW set, it gave no increase in radio frequency power. Fuller soon reported to Elwell that in order to learn to design larger arcs, many things would have to be learned about how performance was affected by changes in a number of design parameters. He immediately set up a development laboratory and increased the engineering group to carry on the design and testing programs. Harold Elliot a Stanford

graduate in electrical engineering, who was also an excellent mechanical engineer, was hired as chief draftsman and from then on handled all mechanical design problems.

This program was very successful as curves plotted from an analysis of the test data indicated how the efficiency of the arc converter could be increased and they were extended to cover the design of much larger transmitters. After tests were made in the field on units up to 500 KW, which proved the design curves, Fuller presented a paper, "The Design of Poulsen Arc Converters for Radio Telegraphy," to the Institute of Radio Engineers in early 1919. This material was also the subject of his Doctors degree in Electrical Engineering at Stanford.

Elwell, in the first draft of his autobiography, says that Dr. Lee de Forest came to San Francisco early in 1911 where he opened an office for the purpose of selling stock in his various radio companies. Sales were not good so in July he came to Elwell saying that he would like to work for Federal. Elwell commented that de Forest had invented the three element tube five years earlier but so far had found only one use for it, as a detector, but that there were other things it might do. An amplifier was badly needed to help in receiving weak radio signals so he hired de Forest to head a team to concentrate on development of an audion amplifier circuit.

Two capable men were assigned to work with de Forest, C. V. Logwood and H. Van Etten. Logwood was a radio amateur and a born experimenter. Van Etten had worked for the Telephone Company so understood the circuits they used.

When Elwell returned from a trip to Hawaii in August, 1912. Logwood showed him their amplifier made up of three tubes connected in cascade. It amplified the ticking of a watch held in front of a microphone, so that it could be heard over a large room through the headphones. There were no loud speakers available at that time.

Later that year, Elwell took the amplifier with him to Washington²⁰ where he demonstrated it to Dr. Louis Cohen, radio expert, U. S. Navy, who

was so impressed that he took it to the Bureau of Standards where tests showed an amplification of 120 times.

De Forest knew that the Telephone Company had been trying to build an amplifier for their long line circuits, so based upon the Bureau of Standards tests, he decided to take it to Western Electric for a demonstration. John Stone Stone, then a consulting engineer in New York City and a former employee of the Telephone Company, arranged for the demonstration which de Forest gave October 30 and 31, 1912.²¹ Dr. Arnold, high vacuum specialist, for the Telephone Company was not present at the de Forest demonstration but he did witness the tubes performance the next day as Paul Pierce an assistant operated the equipment.²²

Mr. W. R. Ballard patent attorney for the Telephone Company writing in the Bell Laboratories Record for July 1931 made these comments on the tests. "The performance of the tube was far short of what, they knew, would be necessary for practical telephone repeater operation. Any attempt to handle loads comparable to those in commercial telephone circuits resulted in choking, blue glow and unintelligible reproduction. Nevertheless, they were greatly impressed with the performance of the audion when the power levels were kept low and the variations in voice currents were small." He said Dr. Arnold felt the tube's performance could be greatly improved by pumping to a higher vacuum. Dr. Arnold immediately began building and testing tubes of higher vacuum and by late Spring of 1913 was sure that satisfactory repeater tubes could be produced. July 1913 the Telephone Company acquired the audion patent rights for repeater use for \$50,000 and later for general radio use for an additional \$90,000.

De Forest returned from his eastern trip in January, 1913, but in May resigned from Federal, taking Logwood with him.²³ They set up a laboratory in New York City with limited manufacturing space for building RJ-4 detectors for sale to amateurs and ultra-audion regenerative detectors for the Navy.

Dr. Fuller says that when he came

with Federal in September, 1912, the amplifier circuit was completed, that several amplifiers were built by Federal for testing by the San Francisco operators. Performance was not dependable. Sometimes they amplified, sometimes they did not. Fuller told de Forest of his work on the small arc used for Fessendens heterodyne receiver, pointing out that if the audion could be made to oscillate, it would be a much better generator than the arc, so the team at once began work on developing an oscillator circuit.

During the summer of 1912, Elwell heard of the planned tests of the 100 KW Fessenden spark transmitter installed at Arlington, Virginia. Specifications for this station called for communication, day or night, over a distance of 3000 miles. He felt this would be an excellent opportunity to get publicity with the Navy if he could get one of the Federal arcs tested at the same time. He went to Washington and finally obtained permission to install the 30 KW set in the station so it could be tested alternately with the 100 KW spark set.

There was considerable objection to including the arc in the tests program but the nightly communication between San Francisco and Hawaii could not be ignored since that distance of 2400 miles was far more than the Navy had obtained with any spark transmitter.

The 30 KW arc was installed December 1912. Using it, the first night²⁴ Arlington communicated with the Federal station in San Francisco and the second night with the Federal Hawaii station, a distance of over 5000 miles. These distance were unheard of at that time, so the Navy immediately became interested in the arc transmitter.

Receiving tests were to be conducted aboard the cruiser Salem during a cruise to Gibraltar and return. She was equipped with National Electric Signalling Company gear, including a heterodyne receiver, an IP-76, a duplicate of the Arlington receiver, plus a Federal receiver with its tikker for receiving undamped waves. The Salem left the Philadelphia Navy Yard February 15, 1913, and the tests continued for almost two months. Results are described by articles in Electrical

World of April 5 and June 21, 1913.

Captain Howeth in his book, "Communications-Electronics in the United States Navy," states the tests showed the arc transmitter with less than half the antenna current of the 100 KW spark set, using the tikker receiver, at distances of 1500 to 2100 miles, gave the same signal strength, but with the heterodyne receiver, louder signals than the spark set. Both transmitters were heard in daylight for a distance of 2100 miles.

The Navy had been desperately looking for radio equipment that could be used to communicate with their foreign bases and hoped that 100 KW spark transmitter under test would have the required range.

Table 2 was taken from the April, 1913, issue of Electrician and Mechanics. It lists all of the Naval stations in the U. S. A. and possessions. They are all spark transmitters having limited range except for Arlington. It is easy to see why the Navy was concern-

ed, due to the low power of most of them. The new Arlington station had been heard in the Canal Zone but it was impossible to communicate with Hawaii, the Philippines and Guam except from a nearby ship.

George Clark was in charge of the Navy receivers on the Salem. He cabled Commander Hepburn, head of the Radio Division, Bureau of Steam Engineering, from the Azores, on the way to Gibraltar, that based on the tests so far, that if larger arcs could be built, they were what the Navy had been looking for.²⁵

Elwell was called to Washington in the spring of 1913 and asked if Federal could build a 100 KW transmitter for the new station at Darien, Canal Zone. At this time, Elwell knew of the failure of the 60 KW set, but he also knew of the development program initiated by Fuller and had confidence in its outcome so agreed to supply the 100 KW transmitter.

According to Howeth, Commander Hepburn based upon the Salem tests,

U.S. NAVAL RADIO STATIONS EARLY 1913

All Spark Transmitters

Data from Electrician & Mechanic April 1913

ATLANTIC COAST			PACIFIC COAST		
Call	KW	Location	Call	KW	Location
NAB	3	Portland, Maine	NPQ	5	St. Paul, Pribilof Island, Alaska
NAC	2	Portsmouth, N. H.	NPY	1-2	St. George, Pribilof Island, Alaska
NAD	5	Boston, Mass	NPV	3-10	Unalga, Alaska
NAE	3	Cape Cod, Mass	NPR	5	Dutch Harbor, Alaska
NLA	2	Nantucket Light Ship	NPS	5	Kodiak, Alaska
NAF	5	Newport, R. I.	NPA	10	Cordova, Alaska
NAG	3	Fire Island, N. Y.	NPB	10	Sitka, Alaska
NAH	2	New York City, N. Y.	NPC	5	Bremerton, Washington
NAI	2	Philadelphia, Pa.	NPD	3	Tatoosh, Washington
NAJ	2	Cape Henlopen, Del.	NPE	10	North Head, Washington
NAK	2	Annapolis, Md.	NPF	3	Cape Blanco, Oregon
NAL	3	Washington, D. C.	NPW	5	Eureka, California
NAA	100	Arlington, Va.	NPH	5	Mare Island, California
NAM	5	Norfolk, Va.	NPI	3	Farralons, California
NLB	2	Diamond Shoal Light Ship	NPK	3	Pt. Arguello, California
NAN	3	Beaufort, N. C.	NPL	5	San Diego, California
NLC	2	Frying Pan Shoals Light Ship	NPM	2	Honolulu, Hawaii
NAO	3	Charleston, S. C.	NPN	2	Guam
NAP	3	St. Augustine, Fla.	NPO	2	Cavite, Philippines
NAQ	3	Jupiter, Fla.	NPT	5	Olongapo
NAR	25	Key West, Fla.	NPP	2	Peking, China
NAS	5	Pensacola, Fla.			
NAT	5	New Orleans, La.			
NAU	5	San Juan, Puerto Rico			
NAW	5	Guantanamo, Cuba			
NAX	25	Colon, Canal Zone			
NAY	1	Porto Bello, Panama			

TABLE 2

ordered ten 30 KW arcs for shipboard use. By this time Elwell had resigned from Federal so Fuller was called to Washington to settle specifications for the Darien transmitter. Howeth states the contract was accepted at the Navy's risk but was signed June 30, 1913. Dr. Fuller says that by that time sufficient data had been obtained from the testing program to convince him that the 100 KW arc would perform satisfactorily.

At a meeting of Federal Directors held in the Spring of 1913, Elwell proposed that based upon the successful operation of the west coast stations, the night link to Hawaii, and the success of the Arlington tests, that Federal should extend its operations to the Philippines, Guam and the Orient. Conservative members pointed to the failure of the eastern venture and voted not to attempt the expansion at that time.

Elwell was not happy with the decision so resigned from Federal²⁶ and went with the Universal Wireless Syndicate formed in England for the purpose of setting up a transatlantic wireless service using arc transmitters. This company soon failed, leaving Elwell on his own. He built arc sets for use in Europe, the largest rated 200 KW intermittent, approximately the same as the Federal 100 KW continuously rated set. He was one of the founders of the Mullard Tube Company of England where he continued to live until WW-II when he returned to Palo Alto.

When Elwell resigned, Leonard Fuller at 23 years of age, became chief engineer of Federal Telegraph Company. In addition to supervising the engineering group, he personally made all of the electrical, magnetic and cooling designs for the large arcs. Howeth states that Fuller designed the antenna system for the 500 KW station at Annapolis and the 1000 KW Lafayette set. In the period 1913-1919 he earned a Ph. D. in electrical engineering from Stanford University, took out 23 patents on design of arc transmitters and related apparatus, and wrote 11 papers and discussions, several of which were presented before the Institute of Radio Engineers and American Institute of Electrical Engineers.

The 100 KW transmitter was installed in Darien in 1914 but testing was delayed until the towers were completed in the spring of 1915. Later, the set passed all tests with flying colors. The station went into service in mid-1915.

Federal entered the marine communication field in mid-1915.²⁷ Arc sets were installed on the Yale and Harvard, passenger steamers operating between San Francisco and Los Angeles. Later that year, arc sets were put on the Sierra Sonoma and Ventura of the Oceanic Line, also on several Union Oil tankers. The call book of 1916 lists 9 ships and the 1917 book 22 ships equipped with Federal arcs. Most of the marine units were 2 KW which had far greater range than the 2 KW spark sets they replaced. It was usual to work San Francisco and Los Angeles from the Orient at night from the arc-equipped ships. Long distance communications were on wavelengths above 1200 meters, since the arcs did not perform well on 600 meters. So spark transmitters were installed in the Federal coastal stations for handling local contacts.

Table 4 gives the Federal Telegraph land stations listed in the call books. Wavelengths on the left with call letters for the years listed on the right. Early call books were not always accurate. The following stations were never listed - Sacramento, Stockton, Medford, Central Point, Kansas City and Chicago. Call letters KFS for San Francisco and KLS for Los Angeles were assigned in 1910 but were not in the call books until 1914.

The lower part of Table 4 shows the six post War stations, three marine and three point to point. This profitable operation continued and in 1927 Federal entered into a 25 year agreement to be taken over by IT&T.

When all stations were taken over by the Navy during WW-I, Federal handled its traffic over the lines of the Telephone Company.²⁸

The early arc transmitters were rated on an intermittent basis but the Navy insisted they must meet the specifications developed for general electrical machinery by the American Institute of Electrical Engineers. These call for continuous operation with a

RADIO STATIONS OF FEDERAL TELEGRAPH CO.

as listed in U.S. Call Books

Station Location	Wave Length	1913	1914	1915	1916	WAR	1921	1922	1923
San Francisco, Calif.	300-3800		KFS	KFS	KFS				
S. San Francisco, Calif.	300-12000		KSS	KSS	KSS				
Los Angeles, Calif.	300-3250		KLS	KLS	KLS				
L. A. (Inglewood), Calif.	-				KFZ				
San Diego, Calif.			KSD	KSD	KSD				
Heeia, Hawaii	300-12000	KHX	KHX	KHX	KHX				
Phoenix, Ariz.	3000-3400	KHQ	KHQ	KHQ	KHQ				
Ft. Worth, Texas	2000-3500	WFF	WFF						
El Paso, Texas	2000-2500	WEP	WEP						
Portland (Lents), Ore.	-			KFU	KFU				
Stations after WW-1									
San Francisco, Calif.	300-1800						KFS	KFS	KFS
Palo Alto, Calif.	300-15300						KWT	KWT	KWT
L. A. (Clearwater), Calif.	300-1800							KOK	KOK
L. A. (Clearwater), Calif.	3375-5500								KNR
Portland (Hillsboro), Ore.	300-1800								KER
Portland (Hillsboro), Ore.	4200-15300						KGH	KGH	KGH

TABLE 4

temperature rise of not over 40 degrees centigrade with an overload of 25 per cent for two hours with not over 50 degree rise. These conditions cause an appreciable increase in size and weight over the intermittent rated designs.

Another Naval requirement was that by merely changing a few switches, any one of five wavelengths could be selected. To accomplish this, a large panel was provided with a long arm rotary switch with five contacts connected to different turns on the antenna

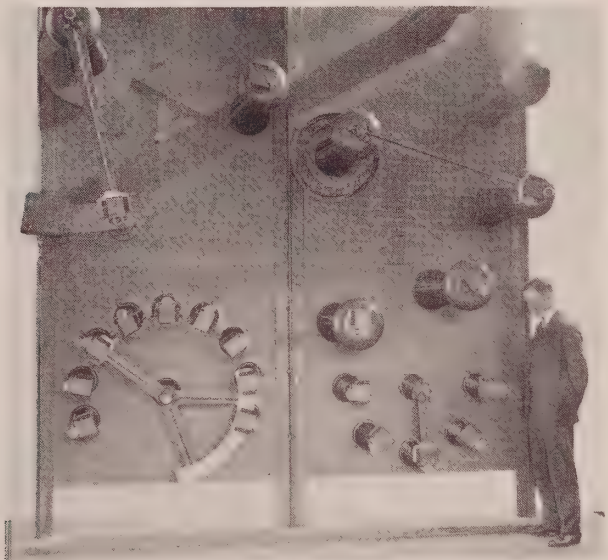


Figure 4 - 500 K.W. Transmitter Wave Changing Switch.

inductance. Comparable changes also had to be made in other circuits.

One of the early problems encountered was the proper insulation of the antenna, since the insulators that were satisfactory for high voltage 60 cycle power lines or for insulating antennas fed by spark transmitters were not satisfactory for insulating continuous currents at high voltage. The high capacity of an insulator string due to the hardware holding the ceramic sections together permitted enough current to flow thru the ceramic discs to destroy them.

Federal set up a high voltage, high frequency testing program²⁹ in Palo Alto, with assistance from the high voltage laboratory at Stanford and the Ohio Brass Company, an insulator manufacturer. The team found the best design consisted of a porcelain tube four to five feet long, approximately four inches in diameter with roughened sections on each end to which hardware could be clamped. Their tests also showed that antenna voltages should be kept below 120 kilo volts to minimize corona losses.

Testing the larger units at near full load presented another problem. The Electrical Experimenter for July, 1919, describes the large dummy antenna they

built that had a rating of 250 amperes, 64 kilo volts at 20 kiloHertz. This antenna had limited radiation so that commercial stations in the area were not seriously affected by the large transmitter tests.

Operation of the ten 30 KW transmitters ordered in 1913 for installation on battleships was so satisfactory that additional orders were placed for enough sets to equip each battleship in the fleet. Smaller 5-10-20 KW sets were ordered for the smaller ships, and 300 2 KW sets were ordered for the expanding Merchant Marine.

Additional manufacturing capacity was needed to meet the demand, so a new factory was built in Palo Alto having approximately 25,000 square feet of floor space with a second floor of 3500 square feet of office space. The building was started early 1916, was soon completed, and direct labor employment soon reached 300 and continued at this level thru WW-I.³⁰

The large transmitters weighed as much as 80 tons but they were built in sections of not over 7-1/2 tons that were bolted together for the final unit.

To return to the Navy program. Howeth states that Congress had approved building high power stations at Darien, Pearl Harbor, San Diego, Cavite Guam and Samoa. Cost of the Darien station with its three 600 foot towers was much more than estimated, but the range was greater than expected so the Navy decided to equip Guam and Samoa with only 30 KW arcs.

Contract for the 200 KW San Diego station was signed February 1916 and the station went into operation in May 1917. The 500 KW sets at Pearl Harbor and Cavite were delayed until the towers were completed but Pearl Harbor went into service October and Cavite December of 1917. The Navy was now in contact with its off-shore bases. Table 3 also shows that by the end of 1917 30 KW or larger sets had been installed in all important domestic bases on each coast plus Alaska. The 200 KW arc at El Cayey, Puerto Rico and the 500 KW set at Annapolis had improved over Atlantic operations.

To insure adequate contact across the Atlantic with our Allies, the Navy decided early in 1918 to build a station

U.S. NAVAL RADIO STATIONS

FEDERAL ARC TRANSMITTERS

Data from Howeth and Dr. Fuller

Call	KW	Completed	Station Location
NAA	30	Dec. 1912	Arlington, Virginia
NBA	100	July 1915	Darien, Canal Zone
NPL	200	Jan. 1917	San Diego, California
NPM	500	Sept. 1917	Pearl Harbor, Hawaii
NPO	500	Dec. 1917	Cavite, Phillipines
NZR	200	1916-1917	El Cayey, Puerto Rico
NPA	30	1915	Cordova, Alaska
NAU	30	1915	San Juan, Puerto Rico
NAW	30	1915	Guantanamo, Cuba
NAD	30	1915	Boston, Mass. Navy Yard
NAJ	30	1915	Great Lakes, Illinois
NPQ	30	1916-1917	St. Paul Island, Alaska
NPC	30	1916-1917	Bremerton Navy Yard, Wash.
NPG	30	1916-1917	Mare Island Navy Yard, Calif.
NVL	30	1916-1917	Seattle, Washington
NAY	30	1916-1917	Pt. Isabella, Texas
NAT	30	1916-1917	New Orleans, Louisiana
NAO	30	1916-1917	Charleston Navy Yard, S. C.
NGL	30	1916-1917	Tampa, Florida
NAM	30	1916-1917	Norfolk, Virginia
NAL	30	1916-1917	Washington, District of Columbia
NPN	30	1916-1917	Guam
NPU	30	1916-1917	Tutuila, Samoa
NWW	30	1914	Tuckerton, New Jersey
NAA	60	1916	Arlington, Virginia
NDD	200	1918	Sayville, Long Island
NSS	500	1918	Annapolis, Maryland
NWW	60	1916	Tuckerton, New Jersey

TABLE 3

near Bordeaux, France having 1000 KW arc transmitters. The antenna system designed by Dr. Fuller was³¹ supported on eight towers each 820 feet high. By October, 1918, all tower material plus the transmitters had been delivered but the Armistice of Novem-

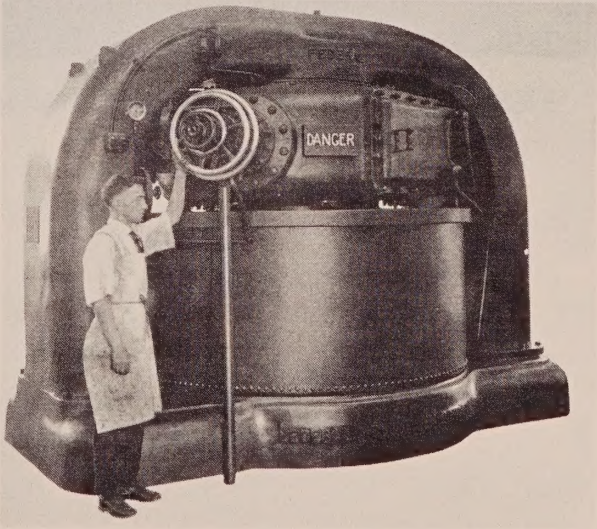


Figure 5 - 1000 K.W. Federal Arc Converter for Bordeaux Station.

ber 11 stopped all work. The French Government later decided they wanted the station and agreed to pay the erecting costs. So work was resumed in May, 1919, and was completed September, 1920, and accepted in December.

Full load antenna current of the "Lafayette" transmitter was 550 and 750 amperes, depending on the wavelength used and weather conditions. While under test, currents up to 850 amperes were measured.³²

This photograph shows part of the Federal engineering group in front of a 500 KW arc, Dr. Fuller on the left end. In front on the table is the 100 watt Danish arc brought to this country in 1909 by Cyril Elwell. In just eight years this small company, without any government subsidy, had improved the design of the small inefficient unit to the efficient 1000 KW "Lafayette" set, the most powerful wireless transmitter in the world.

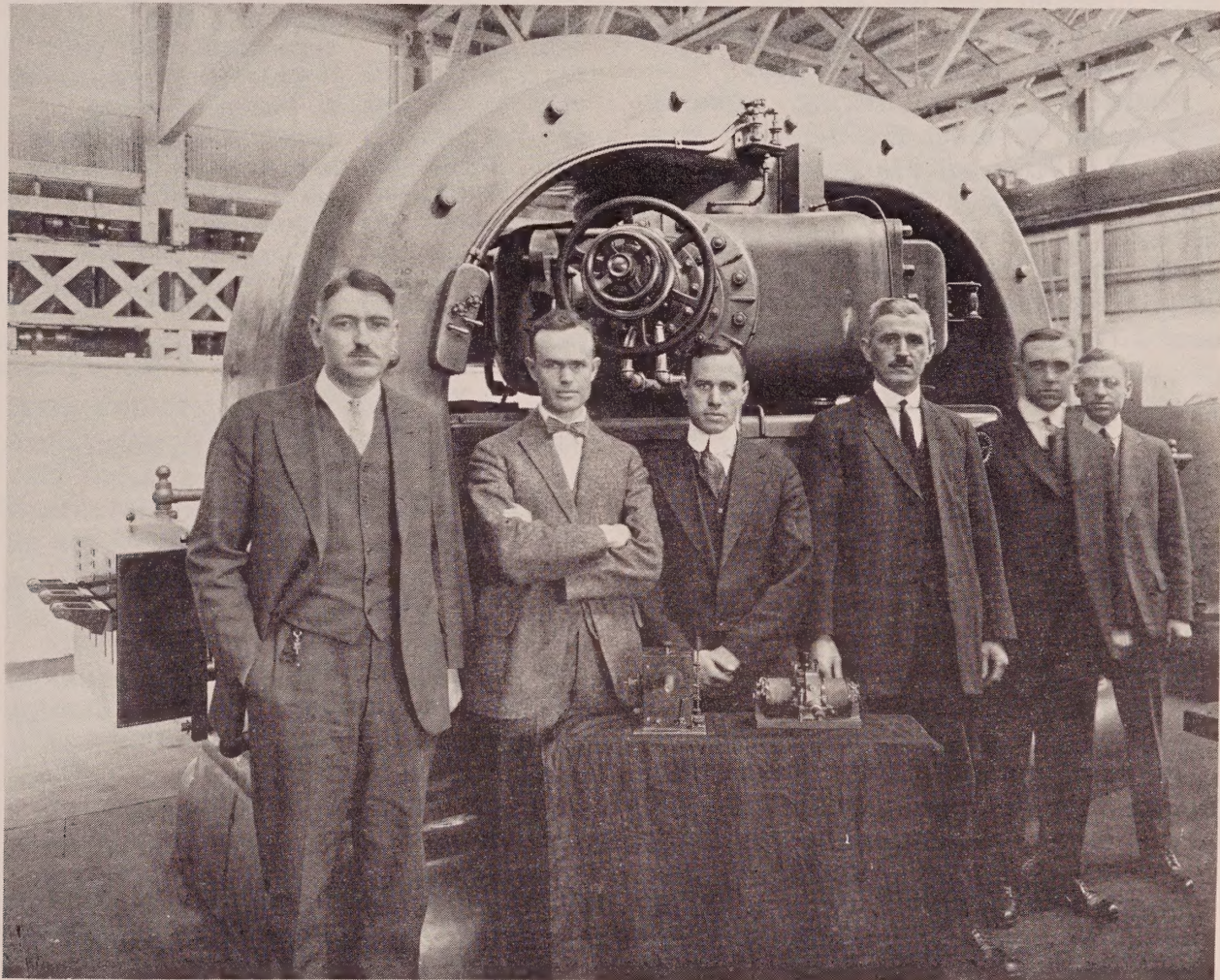


Figure 6 - Federal Telegraph Engineers with 100 Watt and 500 K.W. Arc Converter.

NOTES

- 1- Tape of a talk on Federal Telegraph Company given by Dr. L. F. Fuller. Copies on file at Foothill College Electronics Museum and at Antique Wireless Museum, East Bloomfield, NY.
- 2- Conferences with Dr. Fuller, 1974-75-76.
- 3- Report to Board of Directors, Federal Telegraph Company by C. P. Veeder, Secretary-Treasurer. June 1, 1914 -- Copy on file at Foothill College Electronics Museum, Los Altos Hills, California.
- 4- History of Radio to 1926, by Gleason Archer.
- 5- Principles of Wireless Telegraphy, by Dr. G. W. Pierce, 1910 McGraw Hill.
- 6- Federal Telephone and Radio Corporation, A Historical Review, from Electrical Communications, December 1946, page 379.
- 7- Ibid., page 380.
- 8- Ibid., page 380.
- 9- Veeder report, page 3.
- 10- Ibid., page 3.
- 11- Ibid., page 6.
- 12- Ibid., page 6.
- 13- Ibid., page 6.
- 14- Ibid., page 6.
- 15- Ibid., page 7.
- 16- Ibid., page 7.
- 17- Ibid., page 8.
- 18- Conference with Dr. Fuller.
- 19- From page 81 of first draft of Cyril Elwell's autobiography filed in George H. Clark's Radioana at Smithsonian.
- 20- Ibid.
- 21- The High Vacuum Tube Comes Before the Supreme Court, by W. R. Ballard. Bell Laboratories Record, July, 1931, page 514.
- 22- The Young Man and the Tube, by L. M. Whyte, Western Electric Vol. 25 #7, page 32.
- 23- Magnificent Failure, by Samuel Lubell, Saturday Evening Post, January, 1942, page 43.
- 24- Federal Telephone and Radio Corporation, Electrical Communications, December, 1946, page 381.
- 25- Communications-Electronics in the U.S. Navy, by Captain L. S. Howeth, Government Printing Office, 1963 page 183.
- 26- Conference with Dr. Fuller.
- 27- Discussion late 1976 with Eb Cady, retired manager of San Francisco radio station KFS.
- 28- Conference with Dr. Fuller.
- 29- Ibid.
- 30- Ibid.
- 31- Communications-Electronics in the U.S. Navy, page 244.
- 32- Conference with Dr. Fuller.

PHOTO CREDITS

Figures 1-2-3 From Foothill College
Electronics Museum
Figures 4-5-6 From Dr. L. F. Fuller

© Copyright 1979, ANTIQUE WIRELESS ASSOCIATION, INC.

Single extra copies of this Monograph may be had in U. S. and Canada for \$1.00 each postpaid. Less for larger quantities. Stock limited. Write Dexter Deeley, 8 Briar Circle, Rochester, NY 14618.